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On width of track. By W. R. Casey, civil engineer.

Whatever may have been the reasons which led to the adoption of the present width of track on the Liverpool and Manchester Railway, it will be readily admitted, that no change can *now* be judicious unless it offer advantages not possessed by, or obviate difficulties inseparable from the usual guage of 4 ft. 8 1-2 in. between the rails. The deviations from this width as yet made in the United States, few as they are in number and insignificant in amount, leave us absolutely without any facts by which to show the propriety, far less the necessity, of an increased width of track, in a manner entitled to the confidence of an intelligent Board of Directors. All we can do, then, is to examine the grounds on which the only deviations worthy of notice have been recommended and wholly or in part carried into execution.

These are the Russian Railway, with a track 6 feet wide, constructed by the chev. de Gerstner, and the Great Western Railway, with a track 7 feet wide, by Mr. Brunel. Unfortunately no reports of the working of the former have been received in this country, though M. de Gerstner, when here, was decidedly opposed to any increase beyond 6 feet, and, on the other hand, Mr. Brunel's confidence in the ultimate and triumph antsuccess of his 7 ft. track remains to this day unshaken.

Mr. Brunel had two objects in view in adopting the seven feet guage :—the attainment of an average speed of from 35 to 40 miles per hour, and a reduction of the friction of the axles by increasing the diameter of the wheels of the cars—indeed an increased diameter of wheel may be said to be the aim of this very important change, for, by this means, is obtained the increase in speed as well as the diminution in friction.

There are probably few roads in England on which an average speed of 25 miles per hour, and still fewer in the United States, on which an average of 20 miles per hour is regularly maintained. The rate of travelling on some of the most important thoroughfares in the Union, such as the Utica and Schenectady Railroad, scarcely reaches 15 miles per hour, though

their engines could easily maintain a rate of at least 20 miles per hour, and the engines on good roads such as the Providence, Stonington and the numerous substantial roads leading from Boston could, without difficulty, perform 25 miles per hour, or more if required. The speed cannot therefore be said to be limited to its present rate by the narrow guage, but must be attributed to other causes very well known, some of which are pointed out by Mr. Wood; such as the trifling load, and the immense consumption, of fuel at great velocities. The repairs of road, engines and carriages, offer however, still greater objections, for they increase in a much greater ratio than the speed, and in fact limit the velocity, on cheap roads, to 15, and on the best roads in the Union, to 20 miles per hour.

The maximum grade on the Great Western Railroad is 4 feet per mile, on which inclination, the friction of the axles will as Mr. Brunel says, form 80 per ct. of the resistance, and by increasing the diameter of the wheels from 3 to 4 feet, the friction of the axles will be reduced from 80 to 60 per ct. or inversely as the diameter. (Mr. Brunel appears to have overlooked Mr. Hawkshow's error in stating, that an increase of diameter in the wheel with a corresponding increase in the axle would not diminish the friction—in other words, that the friction is as the area of rubbing surface instead of as the weight.)

There are few, if any roads of importance in the Union, where the inclinations are not at least equal to the angle of repose, and even in this extremely favorable case, an increase in diameter of wheel from 3 to 4 feet would only reduce the friction 20 per ct., supposing the road to be straight, but with inclinations of from 30 to 40 ft. per mile and curves of 1000 or 2000 feet radius, the advantages of large wheels would be imperceptible in practice—the disadvantages obvious.

Increased steadiness was one of the collateral advantages confidently anticipated from the wide track. Mr. Wood's experiments cannot be considered as indicating any superiority in this respect, but Mr. Brunel states positively, that the notoriously worst part of the road gave the most favorable results in the diagrams, and it is indeed very easy to believe that this apparatus for measuring the irregularities of a machine much simpler than itself, and far better understood, would not give any results on which much reliance would be placed by practical men. If the steadiness actually increased with the width, the improvement from an increase of nearly one half should be immediately and plainly perceptible to all, but if it can only be ascertained by a sensitive apparatus contrived for the purpose, this "collateral advantage" disappears in practice. It is remarkable that Mr. Brunel no where states, that the motion on his road is decidedly easier, more agreeable or more uniform than on the narrow track.

The want of room for the most efficient arrangement of the working parts of the engine was, some years since, of itself considered sufficiently important to warrant an increase in width of track. Now, however, little or no difficulty is experienced in the construction of the largest engines, and

the most experienced builders in England, as well as the United States, consider any increase beyond a very few inches absolutely injurious with the present construction of engines.

The propriety and practicability of maintaining an average velocity of 40 miles per hour and the great benefits to be derived from 4 feet gradients are so strongly urged by Mr. Brunel, that, with every respect for his talents, it is difficult to believe he has any practical acquaintance with the repairs and renewals of engines and cars, adjustment of rails, average size of trains and numerous other practical details, experience in which, in this country, goes far to demonstrate that his views cannot be carried out, here at least, requiring as they do, in the first place, an immense outlay to obtain 4 feet gradients and curves of several miles radius, and secondly, an amount of repairs and renewals vastly beyond what is already found so burdensome with only half the proposed velocity, and with less than one fourth of the probable cost.

In justice to Mr. Brunel it should be borne in mind, that he does not consider the wide guage advantageous for roads materially differing from his in curves and grades, and his entire course of reasoning would lead to the conclusion, that the ordinary width of track was too great for roads with grades of 30 feet per mile and curves of 2000 radius. He also refers to the Irish Commissioners, who, with certain curves and inclinations, established 6 feet and 2 inches as the most advantageous width, and feels sure that, with a line as favorable as the Great Western, the same principles would have induced them to recommend a guage of seven feet. The idea that for every series of grades and curves a different width of track should be adopted may be very true in the abstract, and may afford infinite amusement to Dr. Lardner, Irish Commissioners, cis as well as transatlantic "et id genus omne," but it has no attractions for those whose deliberate opinions instead of being confined to paper, are carried out in practice, and in the success of which, they, as well as the stockholders have a vital interest and the community a stake of some importance. Thus if we admit, that 7 feet is the proper width for the Great Western Railway with grades of four feet per mile, and that 4 ft. 8 1-2 in. is the proper guage for the London and Birmingham Railway with grades 4 times as great, or 16 feet per mile, some of the most important roads in this country would be reduced to a width of little more than 3 feet! It is worthy of remark that instead of pointing out the manner in which the present guage acts injuriously, and stating some tolerable approximation to the extent of increase by which these difficulties would be surmounted—(an investigation requiring much labor and skill), it is assumed as self-evident, that a wider track must work better than one of the ordinary dimensions though, for anything deduced from the experience of the United States, the most advantageous width is as likely to be found below, as above 4 ft. 8 1-2 inches.

A velocity of 40 miles per hour is not to be thought of, on the railways of of the United States, the diminution in friction by increasing the diameter

no difficulty is experienced in the construction of the largest engines, and

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of the wheels will only be felt on a level where it is not of the slightest consequence, there appears to be at least no gain in steadiness and "gentlemen's carriages" can be carried over the wheels as well as between them.

The success of the new system cannot be considered certain even with the incomparable grades of the Great Western Railway, and it is not easy to say what will justify its introduction on roads with grades of from 18 to 30 and even 40 ft. per mile and curves of 1000 to 1500 feet radius, unless we rely entirely on improvements to be hereafter made in the construction of roads and machinery or anticipate the eventual adoption of a superstructure far more substantial than any now existing; in short a railway of greater capacity than the London and Birmingham, the present business of which may be considered fully equal to what can ever be expected on any railroad in any part of the Union.

But, without reference to any thing which has been said or done in England, how stands the case in the United States? The present width is sufficient for any engines required in practice, and indeed for much heavier ones than any road in this country is able to bear, the wagons are large enough for greater loads than the wheels and springs ought to be loaded with, and the velocity is limited to its present rate by conditions on which an increased width of track can have at least no beneficial influence. A wider guage must be attended with increased cost of construction, and if the present superstructure and weight of engines be retained, the same load will be carried at a slight increase of cost on account of the additional capital invested in the width of road, cars and engines, supposing the cost of repairs and renewals to remain the same as with the present dimensions—a supposition only too favorable to the increased guage. A greater width of track, with correspoding additional strength in the superstructure and cars, and power in the engines, would undoubtedly enable us to carry at a lower rate than with the present roads, engines etc.,—if the business could not be properly accommodated by a road of the ordinary dimensions. Before therefore determining on any *material* deviations from the present guage [which no one supposes to be precisely the very best possible] it should be ascertained that an amount of business might reasonably be expected, which could not be *advantageously* done on a road of the ordinary width.

This subject has been before the Engineering world in this country for at least five years, during which time many of the best roads have been executed and the very best ones projected and planned. Yet Messrs. McNeill, Whistler & Robinson have retained the 4 feet 8 1-2 in. guage on all their works, some of which are not yet completed, though they have had in numerous if not in every instance "carte blanche," and were indeed bound by every consideration to have adopted a wider track if it would in their opinion have conduced to the efficiency of the road or the interests of the stockholders. In England, the London and Birmingham Railway, the most stupendous work of Internal Improvement on record, has a track of the ordinary width

of the United States, the diminution in friction by increasing the diameter

though leading from the heart of the kingdom to the commercial metropolis of the world, and built by one of the first engineers of the age, who could have introduced any alteration he might have deemed judicious.

The practice of all the best engineers of England and the United States, and the fact, that the present dimensions have worked admirably well, must be considered almost conclusive evidence, that there are no *engineering* considerations, which urge the adoption of a wider guage. Still another width of track *may* be attended with peculiar advantages, and the success and almost universal adoption of the ordinary guage should not deter us from the cool and impartial examination of a greater width, though it should certainly act as a warning from useless innovations and uncalled for changes.

Since the above was in type, the writer has had the pleasure of reading the admirable report of Messrs. Knight and Latrobe, on the "Principal Railways of the Western and Middle States,' and notwithstanding their observations and remarks are confined principally to the proper dimensions of the various parts of the superstructure, repairs of engines, and the general economy of railroads, there is not an expression in the remotest degree alluding to the width of track, though the subjects discussed are precisely those on which an increased gauge is to exert so beneficial an influence, whilst the high standing of the authors forbids the idea of their neglecting any consideration so important as the width of track, if they considered any change desirable or if they had even anything useful or interesting to offer on the subject.

The following view of the cost of transportation on the Utica and Schenectady Railroad with its present "motive power," was made the last winter by a practical engineer well know to us, and is worthy of consideration.

ROUGH ESTIMATE OF COST OF TRANSPORTING FREIGHT ON THE UTICA AND SCHENECTADY RAILROAD, FOUNDED ON "STATEMENT OF 1838."

Albany, March, 1839.

CAPITAL.

Cost of present Road, Engines and Buildings, deducting only costs of Mohawk turnpike and coaches	$1,653,903
1000 wagons *a* $345,097 including platforms, scales, etc.	346,097
Amount of Capital	$2,000,000

Annual Expenses.

Present expenses as per statement,	$115,000
Repairs and renewals of 1000 wagons *a* $50	50,000
" " buildings and shops	8,000
Add 50 per ct. on fuel	6,000
" for oil and tallow	2,000
" for renewal of engines (exclusive of repairs)	10,000
	189,000
Say amount of annual expenses	$200,000

Now $200,000 divided by $\overline{200{,}000 \text{ tons} \times 78 \text{ miles}}$ = one cent and three mills per ton per mile and 200,000 tons *a* 2½ cents per ton per mile × 78 miles = $1,95 say $2, per ton = $400,000

Deduct annual expenses 200,000

Nett receipts equal to 10 per cent on capital $200,000

N. B. Taking the average rate of 3⅔ cts. per ton per mile on the Philadelphia and Columbia Railroad and we have an income of $572,000 26 per ct. on the capital. This is received by the State and does not include the cost of cars, loading and unloading which is done by the forwarders and for which they charge nearly or quite as much as the State. The cost of transportation cannot be less than 5 cts. per ton per mile, twice as much as will pay 10 per ct. in the hands of individuals, but the "free and enlightened" citizens of Pennsylvania will yield to no "monopolies."!!

Railroad Convention.—At a meeting of citizens of the city of New York held at the Repository of the American Institute, on 29th July, inst. Charles Henry Hall, of the city of New York, was called to the chair, and Philip Schuyler and Wm. Paxton Hallett, Esquires, appointed Secretaries.

The President having stated the object of the meeting, and the assemblage having been addressed by Messrs. Clarkson, Crolius, Schuyler, Hallett, Blunt, and other gentlemen, the following resolutions were unanimously adopted, viz:—

Resolved, That in compliance with a call from the counties of Renselaer, Columbia, Dutchess, Putnam, and Westchester, the city of New York cordially responds thereto, touching the importance of the immediate construction of the New York and Albany Railroad, and of the expediency of asking the aid of the State in assisting onward the great work, as well to protect the interest of our own State as to counteract the efforts making by the State of Massachusetts, in opening a line of communication from Boston to the Hudson river, having for its end the division of the products of the West from our emporium of trade.

C. H. Hall, Chairman.

Philip Schuyler, } Secretaries.
W. P. Hallett, }

A novelty appeared in our river last week, it being no less than a miniature steamboat, built for the purpose of testing a new boiler, invented by Mr. John Lille, an ingenious mechanic of this village. The boat is 32 feet long, by 6 wide. The cylinder is 20 inches long with 4½ inch bore, and is supplied with steam by a boiler 2 feet in diameter by 3 feet in length, which stands upright, and will hold 30 gallons of water—with a chamber for 15 gallons more. The boiler is constructed on the strongest possible plan—is of a circular form, containing alternately 4 fire, and 3 water flues. The furnace has a fine draught, and consumes one quarter of a cord of wood per day, producing steam sufficient for an engine of 4 horse power. The inventor thinks the boiler is a great improvement, and intends making application for a patent. This little craft is propelled six miles an hour in still water.—[*Owego Advertiser.*]

The following table will be found to contain a carefully prepared comparison of three important northern railroads.

We cannot too strongly recommend this mode of arranging and comparing railroad information. Figures cannot be ambiguous and they are the fairest representatives of facts. We are much obliged to our friend J. E. Bloomfield, Esq., for this table, and we solicit from him, and from others, a continuation of the series.

Annual Report of Railroad Companies Completed in the State of Massachusetts, and in use, for 1887, '38.

—also—

"Statement relative to the Utica and Schenectady Railroad, January 1, 1839, for the year 1838."

Name.		Expended in cost of road.	Repairs of Cars and Engines	Repairs of Road.	Fuel.	Oil and Tallow.	Salaries & wages Incident'l Expenses	Total Expenses	Income from Passengers.	Income from freight.	Total.	Cost of Road per mile.	Average Repairs of Cars 2 years.	Average Repairs of Road 2 years.	Length of Road.
Boston and Lowell, . .	1837	1.575.663	16.633	14.056	11.177	3216	33.424	78.508	117.643	63.137	180.770	60.802	554	550	25¾
Boston and Lowell, . .	1838	1.575.663	10.945	15.734			48.917	75.597	109.083	82.697	191.780	7 pr ct			
Boston and Providence,	1837	1.682.900	29.794	11.707			114.737	156.238	193.469	57.413	250.882	43.460	606	334	41
Boston and Providence,	1838	1.782.000	19.953	16.856			83.234	120.044	196.974	68.140	265.114	8 pr ct			
Boston and Worcester,	1837	1.000.000	20.053	9.185			65.524	94.762	123.331	86.716	210.047	38.636	406	384	44½
Boston and Worcester,	1838	1.700.000	15.672	12.521	12.854	1985	42.534	85.572	112.032	100.292	212.324	7½ pr ct			
Utica and Schenectady,	1838	1.738.260	16.101	24.121	22.001	3100	54.605	119.950	312.808	18.376	330.695	22.285	206	309	78

Note.—The rails of the Boston and Providence road, are 55 lbs. per yard. The Boston and Lowell, the first track, is 35 lbs.—the second 55 lbs. Boston and Worcester, and Utica and Schenectady 38 lbs. each, per yard. The first track of the Boston and Worcester road, was of the fish belly form, the present is the same as that of the Boston and Providence.

The Legislature of this State have refused the Utica and Schenectady road the privilege of carrying freight, even paying canal tolls, which may account for the difference in the expense of repairs to the road and cars.

We are pleased to hear again from our Meteorological correspondent in the West, after a long interval. The science demands an increased number of observers, and no class of men is better qualified for that purpose than the civil and military engineers of the United States. We shall again advert to this subject.

For the American Railroad Journal, and Mechanics' Magazine.

METEOROLOGICAL RECORD FOR THE MONTH OF JANUARY, 1839.

Kept on Red River, below Alexandria, La., (*Lat.* 31.10 *N.*, *Long.*, 91.59 *W.*)

1839	Thermometer.					
Jan.	Morn.	Noon.	Night	Wind.	Weath.	Remarks.
1	34	58	56	calm	clear	white frost
2	53	57	56	..	cloudy	light showers and drisling all day and night
3	56	58	54	..	..	evening NW light
4	43	44	44	W	..	
5	41	44	43	..	..	
6	42	60	60	calm	clear	
7	50	70	67	SW	..	night cloudy
8	55	68	67	S	..	
9	53	72	69	..	..	evening cloudy, night clear
10	59	73	70	calm	..	
11	64	73	70	..	..	[all night
12	64	64	65	..	cloudy	drisling forenoon, light showers evening and
13	66	65	64	SW—W	..	light rain forenoon, heavy thudder showers all
14	50	52	48	W	..	[the evening
15	38	54	50	..	clear	cloudy morning, evening clear and calm
16	38	51	49	calm	cloudy	white frost, foggy morning
17	44	62	58	..	clear	white frost
18	52	54	53	W—light	cloudy	all day, rain in the night
19	47	45	42	NW	..	..
20	33	44	44	calm	clear	white frost, night cloudy
21	40	45	38	W	cloudy	morning, white frost, clear day
22	28	54	46	calm	clear	
23	34	49	44	..	cloudy	
24	44	46	46	..	..	rain, light showers all day
25	52	55	54	..	..	clear all night
26	41	60	50	SW	clear	
27	34	58	58	calm	cloudy	
28	52	65	68	S—high	..	
29	64	69	52	..	..	
30	44	44	40	.. light	..	rain all day
31	38	34	39	..	..	..
	47	56.3	53.6	.....	.....	mean temp. of the month 52.
Feb.						
1	31	35	35	NW light	clear	night cloudy
2	33	44	44	..	..	
3	28	55	54	..	..	cloudy night
4	44	58	46	N	..	morning, evening cloudy, rain all night
5	43	43	38	..	cloudy	rain all day, snow at night
6	33	35	37	NE	..	snow laid all day, rain and sleet at night
7	32	33	35	..	..	rain and freezing all day, roofs covered with
8	37	42	41	calm	..	snow and sleet melted and [snow & sleet
9	41	47	46	..	..	all day [gone, light showers all forenoon
10	43	48	43	..	..	morning, clear day
11	32	60	47	..	clear	all day
12	34	66	60	..	..	white frost "
13	39	67	60	..	..	" "
14	39	68	63	..	..	" "
15	45	62	60	..	..	all day
16	38	63	60	SW	..	forenoon, evening cloudy
17	46	58	48	..	..	all day
18	36	55	50	W	..	"
19	41	58	54	SW	..	" night cloudy
20	44	58	54	calm	cloudy	all day
21	48	68	62	S	..	rain all night
22	48	51	62	..	..	rain heavy all day and night
23	62	61	60	..	..	heavy rain all day, cleared off in the night
24	55	65	65	calm	clear	all day
25	52	70	64	NW	..	light thunder shower in the evening
26	50	56	54	W	..	all day
27	40	57	51	S high	..	white frost at 5 P. M., a gale and light shower
28	39	57	50	SW	..	white frost [from NW
	41	55.3	51.5	.....	.....	mean temp. of the month, 49.2

We commend to the attentive perusal of our readers the following sensible and well written views on the much discussed subject of Steam-boat explosions.

Mr. Redfield is well known as a practical man, and able at the the same time to call to his aid the results of science. His selection as one of the late U. S. Commission to examine into inventions for preventing explosions, is a further assurance that his abilities are generally recognized and appreciated.

LETTER TO THE SECRETARY OF THE TREASURY, ON THE HISTORY AND CAUSES OF STEAMBOAT EXPLOSIONS, AND THE MEANS OF PREVENTION, BY W. C. REDFIELD.

NEW-YORK, *December* 26, 1838.

SIR: Having recently been served with a copy of the resolution of Congress, moved by Mr. Sergeant, for obtaining information respecting the use of the steam-engine in the United States, in navigation or otherwise, and the accidents which have resulted therefrom, I am led to believe that the inquiry will be best answered by a concise statement of my own observation and practice for the last sixteen years, during which time I have been chiefly engaged in the construction or management of steam vessels.

When I first engaged in the application of steam to navigation, there were, as now, two systems of engineering practised in our steamboats. One of these, the Bolton and Watt, or low-pressure system, had been introduced by Fulton, in which the working power was mainly derived from steam of low temperature and expansive force, working upon an effective condensation; the other the high-pressure system, in which steam of high elastic force is worked against the pressure of the atmosphere. The latter system was early introduced in this country by the late Oliver Evans, who was distinguished for his mechanical talents, and who perhaps exceeded all his cotemporaries in his just apprehension and prescience of the powers and advantages of the steam-engine, as applicable to railroads and to navigation.

My first practical acquaintance with the steam-engine was under the high-pressure system; the adoption of which, in this case, grew out of circumstances not under my control. But an attentive consideration of the principles and practice of the low-pressure system, served to convince me that the claims to superiority, both for efficiency and safety, which had been mutually set up by the advocates of the two systems, could not be justly maintained.

It appeared obvious that the useful effect of highly elastic steam could be greatly increased by acting with less pressure on the surface of a larger piston, working on an effective condensation; while the tension and wearing of the different parts, and the danger of explosion common to high-pressure engines would thus be materially lessened. It appearing equally certain that the engine of Bolton and Watt could be rendered more useful and efficient by adapting it to steam of greater pressure and elasticity than was at that time employed; and that by proper modifications in the structure of the boilers, a degree of safety could also be secured which had never yet been attained. The high-pressure system, as then practised, required a tension of steam approaching, as I conceived, too near the estimated strength of the boilers in which it was generated, to be deemed safe in all circumstances;—a consideration of the highest importance in navigation. It also appeared that the use of low-pressure steam, after the English method, with weak boilers, in which any accidental increase of pressure to the

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amount of perhaps half an atmosphere, could hardly fail to be attended with fatal disaster, was equally unsafe; and that this practice, although universally sanctioned in England, ought not to be followed in our steam navigation.

From these considerations, it appeared to me evident that the greatest degree of safety and efficiency could only be obtained by combining, to some extent, the peculiarities of the two systems, and by adopting such forms of structure in the boilers as should afford the greatest attainable amount of surplus strength, between the maximum working pressure and the point of actual danger to the boiler. I determined, therefore, that in all cases under my control, the extra or surplus strength of the boiler should always be as great as might be fairly practicable;—a principle which, after this lapse of time, I have found sufficient reason to recommend to others for adoption.

Upon this principle of the greatest attainable strength, were also constructed the boilers of the high-pressure steamboat in which, as before mentioned, I was first led to engage. This steamboat was, for the period of four years, under my immediate observation before being dismantled, and during this time, no injury by explosion or erruption of steam, and, probably, not the least hazard thereof, was known to occur; nor do I find reason to believe that, in ordinary hands, the use of these boilers could have been rendered dangerous, either to the passengers on board or to those intrusted with their management.

In the mean time, I was engaged in the first successful attempt to establish steam navigation on the Connecticut river, between the cities of Hartford and New-York, by means of a competent steamboat of low pressure construction. In this case, my own views of safety and efficiency, as before mentioned, would have required an important modification, and addition of strength, in the boiler which was furnished for this boat. At this period, however, the influence which was exercised upon public opinion by the associates and friends of Fulton and Livingston, through the medium of the press and the intercourse between their captains and the travelling public, had extensively induced the belief that the plans adopted in the Fulton boats, and those only, were safe and proper; and a general conformity thereto was deemed to be indispensable, by those who professed to represent the public interests. In this case, therefore, the plan of construction adopted for the boilers and engine was like that of other low-pressure engines then building for the New-York waters; the boiler, which was of iron, being large, and the engine fitted with D slide valves, and adapted to a speed in the piston of 160 to 200 feet per minute, like the English marine engine now in use. It is but just to state, however, that the boiler in question, and also most of those which were used in the Fulton boats, were of greater strength than the boilers which are commonly used in England for low pressure engines. But, on the other hand, the advantages of a greater expansive power were beginning to be understood; and as confidence in the strength of these boilers increased, the practice of increasing the working pressure upon them gradually gained ground, so as ultimately to neutralize the advantage of the increased strength which had been given to them beyond that of the original English models. This steamboat (the *Oliver Ellsworth*) commenced running between New-York and Hartford in the spring of 1824, immediately after the removal of the restrictions in favor of Fulton and Livingston, by the decision of the Supreme Court of the United States; and my connection with this boat terminated in the following year. I have noticed these facts as illustrating, in some degree, the chief cause of the explosions which have since occurred in the steamboats navigating on the va-

rious routes leading from the city of New-York; and the name of this boat will hereafter appear in the catalogue of these accidents.

In 1824–'5, I was engaged in the construction of the steam vessels *Commerce* and *Swiftsure*, and the safety-barges and freighting vessels which have since been towed on the Hudson chiefly by these steamers; having acted as principal engineer and general agent of "The Steam Navigation Company," to which these vessels belonged.* Having been left free in the application of means to ends, except as measurably controlled by the opinions and habits of the contractors and artificers employed, I at once adopted the strongest form of boiler that appeared applicable to the general combinations which were then chosen. The plan of combining the advantages of the high with the low-pressure system, at an intermediate pressure of steam, was adopted for these vessels, as being best suited to the service for which they were designed. At that early stage of our improvements in the marine engine, the plan of uniting these advantages in a single working cylinder, and of making a more efficient application of them by means of an increased velocity of the piston, had not come into practice.† Double engines were therefore employed, comprising two cylinders of unequal diameters, the smaller one receiving the steam from the boilers and delivering it expansively to the larger one; the latter being worked upon an effective condensation. These vessels, with their engines, have been employed for fourteen years, with little modification, and mostly under severe duty; but no accident of an explosive or eruptive character has ever occurred, and they appear capable of rendering good service for several years yet to come. The boilers, during this period, have been twice renewed, on plans combining additional strength and convenience.

I may here state that no accident from the explosion or rupture of a steam-boiler has ever occurred in the steamboats under my particular charge; and the remark might also be extended to other steamboats, which have been furnished with boilers made under my directions. That this result has been chiefly owing to the superior care or skill of my subordinates, who have had the immediate charge of the boilers and engines, I cannot believe; for, trustworthy as were most of these men, they have partaken of the general character of their fellow men, in and out of this profession, and have, probably, no better claims to infallibility. Boilers of a structure which afford the proper degree of surplus strength may be injured as well as others, by the carelessness or neglect of those in immediate charge; but are not likely, even with bad management to destroy life by explosion.

The bearing of the considerations which have been stated should be considered as fully applicable to engines and boilers of every grade, whether for high or low pressure. Nor will the use of boilers of the greatest attainable strength, have any tendency to promote in the engineer a disposition for hazardous or untried adventures, nor to prevent him from appreciating those other substantial improvements in the art or science of engineering, as applied to steam navigation, which have been realized within the last fourteen years.

Having stated the general manner in which the steamboats and other vessels of the Steam Navigation Company have been constructed and managed, it is only necessary to add, that the sale or use of intoxicating liquors

* In this communication I use the term "engineer" in the double sense which common usage has assigned to it in this country, it being descriptive alike of him who controls and directs the specific use and combination of materials which are needful to a machine or superstructure, and of one who is employed in the ordinary charge of a steam-engine.

† For establishing the advantages of this simple combination, if I mistake not, we are mainly indebted to the practical talent of Robert L. Stevens, Esq.

has not been allowed in these vessels for the last eight years, and I believe this rule cannot be commended too strongly.

Explosions of Boilers on the New-York Steamboats.

In May, 1823, the public were astounded by the disastrous explosion on board the *Etna*, while navigating the waters of our bay, a few miles from the city. The engine and boilers of this boat had been constructed upon the plans of Evans, and in conformity with his ultra views in favor of diminuitive passages, both for the steam and supply of water: and she had recently been brought round from the Delaware, and employed between this city and the Raritan. No proper examination of the facts attending this case, such as the interests of the public and the profession required, was ever made; but, as near as could be ascertained from private statements, and the judicial testimony then published, the small pipe through which water was supplied to the boilers had become stopped, or nearly so, by incrustation; and the supply falling short, the boilers were too strongly heated upon their lower surface, and were then left to their fate, while the fire should exhaust itself. Upon this statement, however, I do not think it safe to rely, as all subsequent observation and inquiry have shown me that no statements are more to be distrusted than those which gain circulation under the terrors and excitements of these accidents. I had opportunity, however, to examine the remains of the ruptured boiler, which was of cylindrical form, without flues, about 30 inches in diameter and 20 feet in length, and had been some time in use. The iron plates of the boiler were mainly sound and good, and from the manner in which the boiler was torn, it appeared that the rending, though sudden, was also progressive; and I felt desirous to ascertain, if possible, the first point of eruption. With this object, I traced back the rent from its final termination, on the main part of the boiler, and supposing the parts again restored, successively, to their original position, followed the rent spirally around the boiler, to where it had separated from the opposite end, which had been projected from the boat, and lost in the river. At this point, I found the line of separation passing through one of the rivited joints on the under side, which had stood directly over the fire; *and this joint showed itself to have been previously separated by a crack of long standing, and of considerable extent, in the line of rivets.* This older fracture occupied the space between several contiguous rivets in one of the sheets, and, without doubt, had gradually attained the extent which was then discernable by the oxidated surface, owing to the frequent expansion and contraction of this part of the boiler, and aided, also, by the constant sagging effect of its weight, while supported only at its two extremities.—I will here remark, that boilers of small, or of moderate diameter should always be supported near their centres by lifting bolts, passing through a strong beam above the boilers, or by some other arrangement which is equivalent thereto.

The pressure under which the boilers of the Etna were worked was said to be from 100 to 150 pounds to the square inch, and it is probable that this pressure had been greatly exceeded on some previous occasions.

The explosion of this high-pressure boat, so recently introduced upon our waters, occasioned the greatest excitement; and the opportunity was seized upon to prejudice and exasperate the public mind against the owners and managers of all steamboats which were furnished with *iron boilers*—those then used in the Fulton boats being of copper; and especially was this odium directed against all those whose boats were supposed to approximate to the use of high-pressure. Several new boats were then in the pro-

cess of construction, and the owners of some of these felt themselves compelled to yield to the storm of prejudice in favor of copper boilers of large and inscure construction, approximating to the old English models, with the general exception that the fire was placed within the body of the boiler and the use of the brick-work was dispensed with; and the old dogma of security in the *weakness*, instead of the strength of the boiler, now found numerous advocates. An active and intelligent gentleman, then acting as agent for one of the finest boats at that time building for our waters, on being remonstrated with for yielding his better judgment to this prejudice, and thus endangering the future security of his fellow-citizens who might become passengers, told me frankly, that his owners, as well as himself, were fully convinced of the superior strength and safety of iron boilers, and the advantages of modifying their structure; "but," said he, "we cannot resist public opinion: the people have been instructed that iron is an unsafe material for boilers, and that it is recklessly used because it is *cheapest*. It is beyond our power to disabuse them in this matter; and they threaten us, moreover, that, if we will not give them a boat with a copper boiler they will procure such a one and run it against us. We have concluded, therefore, to give them a copper boiler, the strongest of its class, and have made up our minds that they have a perfect right to be scalded by copper boilers if they insist upon it." I lament to add, that the exercise of this "right" to the use of copper, was attended, within a few years, with a fearful destruction of life, as had been foretold.

I am sorry to add, that the conductors of our public journals were mainly instrumental in enforcing upon the owners of steamboats this false standard of safety, both as relates to the use of copper and to the form of the boiler; and that to this cause must be chiefly ascribed the unhappy destruction of human life which occurred in our New-York steam-boats during the ensuing eight years. Not that all boilers were, in consequence, made of copper, for by far the greatest number brought into use were of iron, because of its known superior strength; but this untoward influence mainly controlled the structure of these boilers, which were generally confined to the strictly low pressure form, exposing greatly expanded surfaces to the action of steam, without producing adequate support. Fortunately, some of those who were then engaged in the construction and management of steamboats, posessesed more firmness than to yield to this influence, and in devising their combinations were governed only by their own knowledge and sense of the means proper to be used, in order to insure both safety and efficiency; and in steamboats so controlled, I am happy to state, such disasters have been entirely unknown.

About the same period, however, two other disasters, of a serious character, occurred in steamboats furnished with *copper boilers*. One of these accidents, on board the *Fidelity*, seriously injured, or caused the death of two or three persons.

The other case was on board the *Jersey*, one of the Fulton boats, employed on the Jersey city ferry. This explosion was second in violence only to that of the Etna; and was less destructive merely from the absence of passengers to be exposed, there being fortunately but one or two persons on board at the time of the accident.

Another fatal disaster occurred also in 1825, with a low-pressure copper boiler which had just been placed on board the steamboat *Patent*, in which the lamented Dood and several other persons, who were exposed, lost their lives. Previous to this, also, the *Paragon*, one of Mr. Fulton's boats, running on the North River, met with a similar accident which was attended with the loss of life. Again, at Elizabethtown point, fourteen miles from

the city, in 1813, a low-pressure boiler on board the *Sea-Horse* had exploded, with a pressure of steam not exceeding five pounds to the square inch.*— But the bearing of all these cases was strangely overlooked, and palliatives were to be found, or uncontrolable causes discovered, by invoking the aid of dangerous and unknown gases: or, some unhappy fireman and engineer was made the scapegoat, who, by his undoubted misconduct or recklessness, had rendered dangerous and destructive, that which had previously been declared to be safe and incapable of serious mischief!

And now came the incitement of active competition on the navigable routes leading from this city, then newly thrown open to all competitors. Old steamboats were found too slow, and new ones were daily acquiring additional speed. So far as this result alone is concerned, this was as it should be; but unhappily, the greatly expanded boiler, whether of iron, or copper, being deemed stronger than was necessary for the pressure which had hitherto been used, must now bear a greater load, and gradually become worked more nearly to its full strength and capacity. In the summer of 1825, the *Constitution*, a new boat, collapsed one of the large irregular shaped flues in her iron boiler, when near Poughkeepsie, and killed or injured several persons. In this case some of the explosion theorists were content to admit that there was no want of water; but loud was the outcry which was again raised against iron boilers.

The next case in order, is the explosion on board the steamboat *Legislator*, in 1825, while lying at our wharves, ready to start on her trip to New-Brunswick. This boat was furnished with a low-pressure iron boiler, of nine and a half feet in dimeter, constructed by the late Robert McQueen, according to the then improved low-pressure pattern. The *interior* shell containing the furnace was about nine feet in lateral diameter, flattened into an ellipse at top, and supported on the outer shell at the bottom and sides by an occasional brace-bolt; the general use of the fastenings not having then received the sanction of our boiler makers. The pressure of steam on the boiler at the time of this explosion was said to be between ten and thirteen inches by the mecurial gauge.† The interior portion of the boiler was violently torn and turned inside out, with the destruction of every thing near the boiler, and of the lives of five or six persons employed on the boat; but the outer shell, which was cylindrical, remainded uninjured. On examining this boiler, I found that the rending was principally in its lower portions at the bottom of the ash-pit beneath the furnace bars. At this point the iron was not more than three-sixteenths of an inch in thickness, and had separated into thin lamellated plates, not having united properly under the roller. Thus the rupture in this case evidently originated at the lowest part of the boiler, at the weakest point, and under a head of some six feet water. But these facts were not investigated, and it was sagely assumed by manufacturers of boilers and other advocates of this stereotyped hypothesis, that this explosion could not possibly have happened had there been a competent supply of water in the boiler. On the other hand, I consider it demonstrable that a boiler of this size and construction, without a thorough system of bracing, is wholly unfit to sustain the ordinary pressure to which this boiler was exposed, and which the managers of the boat believed could be safely borne. But, instead of ascribing this disaster to its true cause, the imperfection of the favorite system of construction, the op-

* Journal of the American Institute for September, 1838, page 646.

† The mercurial tube being bent in the form of a syphon, each inch of elevation causes a difference of two inches in the actual level of the mercury, and an elvation of thirteen inches in the open end of the tube, indicates the pressure of nearly thirteen pounds to each square inch.

portunity was taken to inflame the opposition to iron boilers, and to throw the odium of disaster upon the perished firemen or engineer.

The year 1826 passed off with only one or two slight accidents of this kind among the New-York boats: one on board the *Hudson*, employed on the East River; and another on the *Franklin*, then running upon the North River. Both these boats had low-pressure iron boilers.

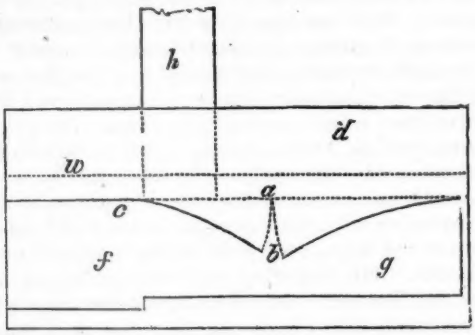
In the spring of 1827, the steamboat *Oliver Ellsworth*, on her passage from Hartford to New-York, when six or eight miles west of Saybrook light-house, in a heavy sea and head wind, burst or collapsed the main flue of her boiler, which occasioned the loss of one passenger, the engineer, and one or two firemen. This case appears to have been universally set down by theorists as owing to extreme carelessness and to want of water in the boiler.* Mr. Penfield, the worthy engineer of this boat, had acquired expeperience during four previous years in my employment, and I had ever found him a man of great care, prudence, and faithfulness. He had changed his employers, with my consent, on the opening of that season, in order to avail himself of a more tempting offer which was made him by the managers of the Oliver Ellsworth, on account of his known good qualities. He knew the value of the principle of surplus strength under which he had acquired experience, and was well acquainted with the condition and management of the Oliver Ellsworth. His first effort, as he then informed me, was to induce the managers of this boat to introduce braces into their boiler, in order to secure the large main flue, which was *four feet* in diameter, made of quarter-inch iron, without other support than that afforded by the connexions at its two extremities. But his views of security were deemed as savoring to much of high-pressure, and it was decided that a boiler which had occasionally sustained a pressure of 15 or 17 inches of steam by the mercurial gauge,(!) could be safely run with a pressure of 12 to 14 inches; and the too modest engineer had no remedy but submission. I had estimated a pressure of six inches as being safe for this boiler when constructed, while others of high authority in these matters then deemed it entirely safe with nine inches. On the evening of the accident, the engineer was watching both boiler and engine with great care and anxiety, being instructed to keep a full head of steam, in order to encounter with success a strong head wind and sea. He accordingly kept from twelve to thirteen inches, with a full head of water and, to prevent the latter from discharing into the cylinder by the motion of the boat, was obliged carefully to tend the throttle-valve, and was actually thus regulating the action of an *overfilled* boiler at the moment in which the explosion took place. He survived the disaster several weeks, and gave me from time to time under no apparent bias but the love of truth, a far more circumstantial account of his care and management on this occasion, than can be here introduced. But his cares and anxieties were unavailing, and he was doomed to the infamy of having been the careless or rash instrument of destroying the lives of his fellow beings, by the inconsiderate advocates of the common explosion-theory, who, in opposition to all evidence, can decide by mere intuition, the want of water in the boiler and the criminality of the engineer!

Although confident in the accuracy of Mr. Penfield's statements, I did not fail to examine closely the condition of the boiler, after the accident.—Its general construction was not unlike that of the Legislator; having an elliptical shaped interior furnace of eight and half feet in lateral diameter, and six feet in length, from which extended a circular main flue of twelve

* See certain well intentioned communications in Document 31, House of Rep. 25th Cong., 3d Sess ion.

feet in length, and four feet in diameter; a smaller returning flue, of irregular form, leading back to a point near the furnace, where it turned upward through the top of the boiler, and was there joined to the chimney. This returning flue, on account of the irregular form, was partially sustained by means of a few brace bolts, but no securities were provided for sustaining the great flue or interior shell of the boiler. A longitudinal outline, showing a vertical section through the centre of the main flue, is here represented:

A vertical section of the Oliver Ellsworth's first boiler.



f, furnace flue; *g*, main flue; *w*, water line; *d*, steam-chamber; *h*, chimney; *a*, point of fracture; *b*, disruption. Scale, 1-8 inch to a foot, or 1-96.

On examining the parts which, in case of a deficiency of water, would have been first exposed to the action of the fire, it was found that neither the top of the furnace flue at *c*, immediately over the fire, nor the top of the main flue, on the same level, nor any other part of the flues, appeared to be in any manner affected by the heat; but, on the contrary, the iron on the upper part of the flue appeared to be, for the most part, as clean, and in as sound condition, as during the first use of the boiler, with but one exception—now to be noticed. This exception was found in the line of fracture at the point *b*, where the curved lines represent the position to which the highest point of the main flue had been depressed by the disreputive force, and by which the original fracture at *a*, had been extended around nearly half of the circumference of the flue; the circular top of the latter, being depressed into the form of an inverted curve, extending from the fracture in opposite directions. Now, at the point *a*, (which is placed at *b*, by the disruption, as just mentioned,) the trace of a previous fracture in the line of rivets was distinctly visible for some eight or ten inches, transversely to the top of flue, which fracture, judging from its appearance, must have existed for a considerable time previous to the final disruption.

Nothing, therefore, could appear more certain than the fact of a full supply of water previous to and at the time of this accident; and the disruption was evidently caused by an amount of working pressure to which the diminished strength of the boiler, at this point, proved to be unequal, although the boiler had sometimes been worked with even a higher pressure, before the incipient fracture here noticed, had originated or become so extensive.

In the boilers of the Etna, as in other cases where the boilers have been long suspended by their two extremities, this insidious sort of fracture was induced at or near the *lower surface*, by the joint action of weight and unequal expansion; but the main flue of the Oliver Ellsworth was constantly

surrounded by water, and pressed *upward* by a force equal to the whole weight of water displaced by this capacious flue, which, after deducting the weight of the flue, is equal to more than 10,000 pounds.* The fracture, in this case, therefore, was gradually induced at the *top* of the flue, which was also most exposed to heat & the unequal strain of expansion. The origin of this species of fracture may, perhaps, be referred to the process of manufacture, in which it is common to force the rivet-holes, which do not properly overlie each other, by driving a steel pin into the same; a practice which is well calculated to cause the sheets to separate in the line of rivets.

This disaster induced the owners of the Oliver Ellsworth to procure a heavy copper boiler, in compliance with the clamor against iron boilers, which on this occasion was again renewed. At a subsequent period this boat was purchased by myself and associates, and transferred to the Hudson river; care being taken to remove her large copper boiler, and to furnish her with a boiler constructed on the before mentioned principle of giving the greatest practicable amount of strength, beyond the working pressure that could conveniently be obtained. The result has been that this boat has not only run with entire safety, but is, even now, with her antiquated engine, much more serviceable and efficient than when employed upon her original route, although the steamers constructed contemporaneously with this vessel have disappeared from our waters. In truth I consider this steamboat as being at this day far more safe from fatal casuaties than most of the steamboats now on our waters. The boiler is sometimes worked with a pressure of two atmospheres above the common boiling point, while it possesses a strength which will bear a pressure of eight atmospheres, leaving a range of strength equal to more than six atmospheres between the maximum working pressure and the point of proximate hazard; and this is believed to have been accomplished without any sacrifice either of original cost or of economy in the use of fuel. If a proportionate range of surplus strength had always been given to the boilers of marine engines, it is believed that steamboat explosions would seldom, if ever, have been heard of, notwithstanding the hypotheses which are so generally and confidently relied upon as accounting for these explosions.

In April, 1830, the steamboat *Chief Justice Marshall*, employed on the Hudson, burst her boiler, while landing passengers at Newburg, by which 11 persons were killed and many others wounded. This boiler was of stout copper, and very strongly built, on the "low-pressure plan," and was more thoroughly *braced*, it is believed, than any other boiler of its date. The structure, however, was a very large one, on the general plan of the boilers in the Legislator, Oliver Ellsworth, and other boats of that day; the main flue being also circular, and five feet or more in diameter. The disruption we are informed, "was ten feet back from the front of the boiler, and was probably eight feet in length by four in width, *commencing nearly at the bottom of the flue, and extending upwards a little over one-half of its diameter.*"

We may safely infer that this explosion, commencing near the bottom of the boiler, and four to six feet below the water-line, was not occasioned by want of water. The principal engineer, who survived the accident a few hours stated to the captain, near his last moments, that there was less than sixteen inches pressure on the boiler at the time, which is probably true; and it is admitted that the steam was "blowing off" through the safety-valve during the entire stoppage till the accident occurred. That there was some unknown defect in the boiler, as was supposed by the engineer, is not improbable; but neither engineers nor captains had then learned, that such

* The length of the furnace is included in the estimate.

a structure, of such material, was unsuited for that pressure. The ardent advocates of copper boilers and the zealous manufacturers of public opinion, were now liberal in their denunciations of the unfortunate engineer, who, in their view by the clearest evidence, had been guilty of criminal neglect or recklessness, in allowing the water to become so wasted or reduced as to occasion this dire catastrophe. Many persons insisted that nearly all the water in boiler must have been previously exhausted. To have sought for *facts* on which to support so grave a conclusion, would have been deemed an insult to common sense; especially as persons had been brought forward, who, under their oath, had testified to the previous warning which they had heard in the shrill and piercing *whistle* with which the discharge of steam was attended previous to the explosion. But, alas for common sense! this thrilling whistle had pierced the ears of the writer, most uncomfortably, thrice in a week for several previous years, while in his office in the vicinity of the wharf occupied by this steamboat; and was known to be owing to some unfortunate peculiarity in the construction of the safety valve or its appendages! It is hardly necessary to add that the upper and most exposed surface of the flues of this boiler were found by good judges, to exhibit no traces whatever of injury by heat—a circumstance which is entirely incompatible with the supposed enormous deficiency in the supply of water.

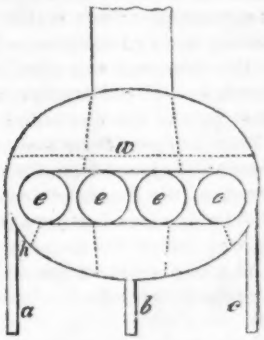
The owners of this steamboat, having once been made the instruments or victims of a fictitious public opinion, now adopted awiser course, and procured two strong *iron* boilers, of moderate dimensions and better suited to the pressure of sixteen or eighteen inches which their engine required; and during the remaining years of her service, this boat was run without injury to her boilers. It may be noticed that this disaster was more fatal in its results than all the explosions or disruptions of iron boilers which had then occurred on the northern and eastern routes from this city. Had this boiler been constructed of iron and secured in the same manner, is it not probable that it would have given way, even with an addition of several pounds to its maximum working pressure, had such addition been fairly practicable.

In the same year there occurred a similar disaster on board the steamboat *United States*, running between New-York and New-Haven, by which several lives were lost. The boiler of this boat was of iron, but constructed on a plan similar to those which have been mentioned. The boat was opposite Blackwell's Island at the time of the accident, with twelve and a half inches of pressure—having frequently worked with fourteen inches. This boiler, which had been recently repaired, also gave out near the bottom of the main flue, its upper portions and the roof of the furnace remaining uninjured; and yet we continually hear that nearly all of these accidents have been occasioned by the want of sufficient water in the boiler! Notwithstanding the severe lesson then recently received from the Chief Justice Marshall, and the explosion of almost every copper boiler which had been continued in use, we were again warned by the public journals against the hazard and cupidity of using iron boilers.

In 1831, the boiler of the steamboat *General Jackson* exploded on the Hudson, at Grassy point, while stopping at the wharf. This was a large, low pressure iron boiler, carrying, it is said, fourteen inches of pressure at the time of the disaster; the safety-valve being open, and the steam blowing off for some minutes previous. But the escape of steam was not, perhaps, as freely allowed as it should have been. The boiler being under deck, and breaking out through its bottom, the force of the explosion threw the boiler out of the boat and into the river, demolishing the deck and causing the vessel to sink at the wharf. The boiler was a large and unwieldly struc-

ture. It was partially braced, but without a thorough system of these fastenings, and was elliptical in its form, being, if I mistake not about eleven feet in its lateral diameter, and presenting a cross section of nearly the annexed form.

Cross section of the boiler of the Steamboat General Jackson.



Scale 1-8 inch to a foot, or 1-96.

The fire was beneath the boiler, instead of within it as in the foregoing cases; the dependant portions *a*, *b*, *c*, being what are technically called water-legs, and riveted to the main shell of the boiler, which was here perforated with large openings to allow a free circulation of water. The return flues *e*, *e*, *e*, *e*, were circular, and united at their extremities by attachments, and terminating in a square cross flue, which communicated with the chimney; and *w* shows the water line. The rending, when traced to its point of commencement, appeared to have originated at the angle *h*, where the water-legs joined to the boiler;* and whatever influence the large perfoations in the shell may have had in weakening the structure, it is certain that the riveted joints on the line of disruption showed several preliminary fractures, of considerable extent, of the same character as those already pointed out in the boilers of the Etna and the Oliver Ellsworth, and one of these was particularly obvious at the point *h*.† The other portions of the boiler appeared to have been previously in good order; and the flues, and their flat connections, though soonest exposed to any deficiency of water, were as entire and as perfect in their condition as ever. Nothing, however, could exceed the storm of indignation which was raised against the captain and the suffering engineer for their supposed criminal negligence or recklessness in this matter; and instead of ascribing the disaster to the obvious weakness of the boiler, iron boilers were as before, held to be worthy of all proscription.

We now arrive at a period when the old low-pressure boilers, and those which were constructed according to the requirements of public opinion at the epoch of the Etna's explosion, had been destroyed or laid aside. A gradual improvement had in the mean time taken place in the construction of boilers, which, although leaving much to be accomplished, had gone

* Under this point also, the planks were started from the bottom of the boat, which caused her to sink.

† When this kind of fracture occurs on the outward lapping of the sheets, it usually causes a leak and is easily discovered; but when it occurs on the *inner* lap of the boiler iron, it sometimes will remain tight for a long period. I have known this fracture to extend, in a high-pressure boiler, to *fourteen inches* before it was detected; which with the ultra pressure sometimes used on the Mississippi, would surely have caused an explosion.

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far to remove the immediate danger of explosion. But with the new method of working the steam expansively, in a single engine of increased stroke, there was also introduced an extension of the steam chamber of the boiler, vertically, around the flue of the chimney; this extension being of the cylindrical form, and technically known as the *steam chimney*. In the summer of 1832, the steamboat *Ohio*, one of the largest on the Hudson, burst the interior shell of this appendage to her boiler; by which five persons lost their lives, three of whom were passengers. The boiler was under a pressure of 14 inches at the time, and was often worked with 18 inches, and sometimes with 20 inches. The disruption took place about a foot above the water line, in that part of the flue which is ordinarily subject to a high degree of heat. *This flue was three and a half feet in diameter*, unsupported by suitable brace bolts; and from the description of Mr. Ewbank, published in the Journal of the Franklin Institute, it appears that the iron had been much injured by previous heating and exposure. That such a flue should have given way under the above pressure is not at all surprising. Since that period a like accident has occurred in our harbor, in one of the Charleston steamboats, by which several lives were also lost, chiefly of her own crew.*

But we have still to notice a more serious disaster than either of the foregoing, which has attended the use of copper boilers. The disruption of the boiler of the Oliver Ellsworth, and the warfare of the press against the use of iron boilers, induced the owners of that boat to provide a copper boiler, as the only means of restoring confidence. This boiler was of unusual thickness, and secured in a manner surpassing that which had been previously practised. The new boiler was worked with a pressure of 13 to 18 inches, and when the boat subsequently came into my hands as before noticed, showed evident effects of this pressure upon its form. A faster and more modern boat, however, was soon required in her place; and a new one was constructed, called the *New-England;* and the managers, in the face of repeated warnings of the comparative weakness and insecurity of copper, felt bound again to conform to public sentiment, and accordingly furnished their new boat with copper boilers. These were of the ordinary thickness; constructed with two fire arches in each boiler, together with five return flues of circular form, and 16 inches in diameter. These boilers had they been of iron, which was then used in nearly all other boats, would probably have sustained any pressure that was likely to be required in the use of a modern expansive engine of ten feet stroke; but the strength assumed or estimated for these copper boilers by the manufacturers, unfortunately, was nearly if not quite as great as iron of the same thickness could have borne. On the 9th of October, 1832, which was soon after this boat commenced running, her boilers were both exploded, with a pressure of 28 or 30 inches, while landing passengers at Essex, on Connecticut river, and about twenty lives were lost on this occasion.

The influence of the press in favor of copper, as may have been seen, had been generally overruled by practical men; and the effect of this disaster was such as nearly to put an end to the use of copper in this part of the country. But some of the conductors of the press who had been most active in establishing the untoward influence by which the owners of this boat had been governed, were now loudest in their denunciations; and men

* On board the steamboat Wm. Gibbons, on the 21st of January, 1836; which is the last steam accident which has occurred to the boats running from New York.

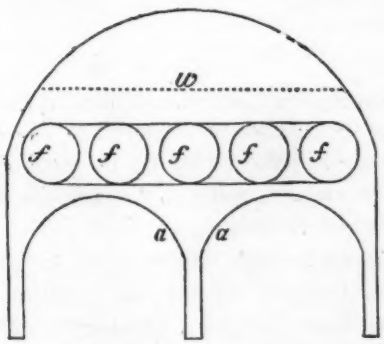
It may be here remarked, that no reliance for strength, should ever be placed upon the circular form of the boiler metal, when the pressure bears upon the *outside* of the curve; except when its diameter is less than 24 or 18 inches; and in *no case* where the metal is exposed to heat, above or near the water line, as in the "steam chimneys."

of the highest integrity and benevolence, who had perhaps exceeded all others in their well meant efforts and sacrifices in order to insure safety, were held up to public odium as being, virtually, the murderers of their fellow-citizens.

The proprietors of the New-England, subsequently to the ordinary judicial inquiries, instituted a thorough investigation of the causes which led to this fatal explosion. They procured the attendance of a board of examiners, comprised of persons from different parts of the country, deemed competent to the investigation; and every facility was afforded for the most full examination and inquiry that the case admitted. The result of this examination, as given in the report of the board, has been already published; but its importance, as connected with the history of steamboat explosions, and its bearing on the future safety of steamboats, induces me to annex a copy of the same to this communication; and which is herewith respectfully submitted. [See Appendix.]

I will, however, add here, for the benefit of those who may not have opportunity to examine this report in full, a summary of the facts in evidence, and of the results to which the examiners arrived.

This boat had been running but little more than a month, and was fitted with two boilers, each about 8 or 8 1-2 feet in diameter and 16 feet in length, placed on the guards behind the paddle-wheels, and outside of the hull of the boat. Their construction may be understood from the annexed figure which represents a cross section of the boiler, near where the disruption first took place.



a, *a*, lower flues or arches; *f*, *f*, *f*, *f*, *f*, returning flues; *w*, water line.

The shell of the boiler was torn open in the lower arches, and spread outward till its parts met in an inversed position, and was thrown some distance from the boat. The flues and steam chimney were uninjured by marks of heat or otherwise, and those of one boiler were thrown forward against the paddle wheel cover, while the other was thrown over the same into the river. The parts of the deck or guards lying beneath the boilers, including the beams, were entirely blown off. This effect, which was directly beneath the apparent origin of the fracture, when taken in connection with the direction in which the parts of the boilers were thrown, appeared to indicate that the disruption commenced in the lower flues or arches, at the places which had shown indications of straining, or leaks, on previous passages, (near the points *a a*,) and which had already received repairs. The engine remained uninjured, but the steam pipe of the boiler which first exploded, was found broken entirely off from its fellow,

at the point of junction in the engine room, by the force of the explosion.* The safety-valve was attached to the main steam pipe in the engine room, near its junction from the two boilers, and was found in good order. A mercurial gauge, which was affixed at the same place had not discharged its mercury, and two similar gauges were attached near the boilers, in one of which the mercury was also found. These guages had been so charged as to sustain a maximum pressure of about 32 pounds to the square inch! The pressure at the time of the explosion was therefore *below* this point.

The copper of these boilers was rolled to the thickness of Nos. 3 and 4 of the wire gauge, or 1-4 of an inch nearly. No marks of heat or of the absence of water, could be discovered on the flues or on the flat work connected with their upper extremities, where a deficiency in the supply of water would first have exposed the metal, and where, in such case, injury or fracture could not fail to have resulted, with even a lower pressure of steam than was known to be on the boilers at the time of the explosion. In short, every appearance on those parts of the boilers which were exposed to heat, appeared to indicate that a full supply of water had been maintained. The weakest portions of the lower arches appeared inadequate to sustain a pressure of 30 pounds to the square inch. It came out in the testimony that the maximum working pressure in these boilers had commonly been from 14 to 17 pounds; that immediately previous to the explosion, it had accumulated, from stoppages of the boat, *to over* 28 *pounds!* And furthermore, that the engineers and firemen had been led to believe, by the manufacturers, that these boilers would sustain a pressure of even 50 pounds to the inch!—an opinion which there is no doubt was honestly entertained by the latter.

(To be continued.)

It is with great pleasure that we commend to the attention of our readers the following paper on Suspension Bridges—by one of our most able and enterprising young engineers. He has the merit of having been one of the foremost in drawing the notice of the profession to this most beautiful and economical mode of structure.

A striking indifference has hitherto been shown in this the land of their origin to suspension bridges—and yet few countries present positions more favorable to this form of bridge. Rapid rivers with steep banks, and a considerable navigation are intersected by roads much travelled and needing an uninterrupted and uninterrupting mode of transit.

We have seen in the possession of A. Blanc, Esq. C. E., recently from France some most beautiful drawings of wire suspension bridges of very large span. Mr. B. informs us that a large number of these bridges are

* This fact deserves special notice; chiefly, because the explosion of the two boilers of the New-England at nearly the same moment, has been gravely brought forward as proving the disaster to have resulted from want of water! But the boilers were alike in their structure, and both subjected by the connection of their steam-pipes, to an equality of pressure; and being charged to the limit of their strength, it is not seen why both should not give way, especially under so powerful a shock, in addition to the pressure, as was necessary to separate the steam-pipes; which blow must alone have been equal to many tons. On the other hand, the boilers were supplied from separate pumps and pipes; and were a deficiency of water found in one boiler, it could have no connection with the state of water in the other. It is on such shallow grounds, that hypotheses and opinions are defended which appear to have a direct tendency to perpetuate these disasters. It was under the delusive notion of *security in a full supply of water*, that these boilers were exploded.

now in progress of construction and that their use even for Railroads is becoming quite common.

We have long been favorably impressed by the suggestion of Mr. Elliot—that a suspension bridge would be the most suitable mode of conveying the Croton Aqueduct across the Harlem river. Many objections have been adduced, but from an intimate acquaintance with the nature of the locality—from frequent consideration of the subject and from an interchange of opinion on the subject with many engineers, we do not hesitate to say that this mode of structure may be made the safest and be finished in the shortest space of time.

No objections can be advanced that cannot be readily answered, and it is very certain that the original cost of a suspension bridge will be less than that of a failure of the mode at present proposed for crossing. Leaving out all consideration of the rapidity of completion and other attendant advantages, we cannot but consider this as a most admirable opportunity for constructing a wire suspension bridge that shall be as creditabte to the taste as profitable to the purse of our city.

With our acknowledgments to Mr. Ellet for his paper, we propose the further consideration of this subject, and shall be happy to give a place to any communications on this subject.

A POPULAR NOTICE OF WIRE SUSPENSION BRIDGES. BY CHARLES ELLET, JR., CIVIL ENGINEER. [HISTORICAL NOTICE.]

1. The Suspension Bridge is not a recent invention. It is hardly to be doubted that it was used, in the simplest form, at as early periods as any other species of construction which has called into exercise the mechanical ingenuity of man. And, without adopting the fanciful idea of a modern writer, that the first efforts of the kind were in imitation of the spider, it is easy to perceive that a precarious passage might be obtained by stretching a grape vine across a ravine, and securing its extremities to the limbs of trees on the opposite banks, without an assumption of greater sagacity than might be attributed to our own species, in its most primitive condition.

2. Among the earliest and rudest attempts in this department of architecture, are those bridges described by Humboldt, Don Ulloa and other writers, by means of which the gorges in the passes of the Cordilleras in Peru, and some of the mountain torrents of India, are traversed by the natives of those countries. Suspension bridges of considerable importance, are here sustained by cables formed of twisted roots supporting a flooring of bamboo.

These structures are frail, and the footing which they offer is unsteady, of course. But great as may seem the contrast between these rude attempts of an unlettered people, and the more recent efforts of European engineers in the same department, it is not greater than would be observed in every other branch of practical science. The passage from the earliest Egyptian lintel, to the arches of Rennie, in England, and Perronet, in France; from the hut of the savage to the dome of St. Peter's or the Pantheon, might probably call for equal admiration.

3. There is nothing remarkable in the extent of the improvement in the partuiclar branch of architecture under consideration; although it may be regarded as a matter of surprise, that the application of the principle should have been so long confined to remote and uncivilized countries. The circumstance is probably attributable to the fact that it is not much more

than a century since the laws of the curve formed by the links of flexible chain, suspended by its extremities, has been known to mathematicians; and it is still more recently that the science necessary for such investigations began to be familiar to persons engaged in practical pursuits.

It is consequent, only within the last 40 years that the subject has at all commanded the attention of practical men. Some successful attempts, on a moderate scale, were made in the United States about the year 1800; but having been executed on a very economical plan, and before the subject was properly exposed by the investigations of modern engineers, these specimens offerd no inducements for the extension of the system, and it has since fallen into neglect, if not disrepute.

4. The example exhibited by these early efforts in our own country, were not, however, altogether lost. It is even probable that to their seccess is due the design of the famous bridge across the Straight of Menai, between Wales and the Island of Anglesea. The width of the straight, at the point where this structure was to be erected, was 1000 feet; the depth of the water at high tide 48 feet; and an indispensible condition, to be satisfied by the plan, required that the edifice should offer no obstruction to the ships navigating the channel.

Stone arches were out of the question, both because the depth of the water rendered the construction of piers almost impracticable, and no span could be attempted wide enough to permit the safe passage of a ship beneath the arches. The same objections would apply, though with less force, to a wooden superstructure; and though a cast iron arch was suggested, and was practicable, the consideration of the cost of such a work led to its rejection.

To obviate these difficulties, Telford, one of the most illustrious of modern engineers, proposed a suspension bridge—or revived such a proposition previously submitted by another—and was charged by a committee with the preparation of suitable plan.

This is the first important suspension bridge that was construced in Europe; and it is still justly regarded as one of the noblest specimens of art in existence. The distance between its points of support is 580 feet; the flooring is sustained at an elevation of 128 feet above low tide, and ships pass beneath it under full sail.

5. The success of this experiment was the signal for the prompt extension of the application of the principle of its construction; and its adoption for many sites, both in England and on the Continet, where the difficulties, or anticipated expense, had previously prevented any attempt at the erection of bridges.

The Minister of Public Works in France, appointed a distinguished engineer, M. Navier, with instructions to proceed to England, and examine the most approved works of the kind in that kingdom, and report in detail on their cost and construction, the principles of their equilibrium, the adadvantages that would result from their introduction into France.

The memoir submitted to the Academy of Sciences of Paris, on the subject, by this officer, forms one of the most beautiful applications of science to objects of practical utility, with which the profession of the engineer is enriched. The work received the approbation of the Academy, of which its author was elected a member, and a board of engineers added the sanction of their approval in recommending the subject to the attention of government.

6. About this period, 1823, M. Seguin, a practical mechanic of Lyons, constructed, at his own cost, a suspension bridge across the Rhone, at Tournon, of a material which had not yet been used in any structure of consequnce. In this bridge a series of cables, manufactured of iron wire, was substituted

for the wrought iron chains which had been previously employed for the support of the road way. And in the memoir which followed soon after, the same individual described very minutely his mode of constructing these bridges, and sustained the merit of his plans by many cogent and irresistible arguments.

The experiment, though a rude one, was regarded as successful, and was immediately repeated, in a superior style, at many points on the same river, and subsequently in many other places in France, and in other parts of Europe. The system spread with extraordinary rapidity, and there is now no mode of construction in such general use, and few bridges of any other description erected on the continent.

They are to be found spanning all the principal rivers of France and England, substituting the ferries at difficult points, and affording access to important places which had, before the improvement of this art, been precluded from the benefit of a bridge.

PARTICULAR ADVANTAGES OF WIRE CABLES.

7. The bridges which it is the object of these remarks to recommend, are sustained by wire cables, stretched between appropriate supports of masonry. The cables are formed of an assemblage of strands of wire, about the diameter of a common writing quill (No. 10, in commerce) which are laid parallel to each other, in the process of their manufacture, and afterward collected in a solid mass, and bound together by ligatures of the same material. The number of strands in each cable depends on the strength which it is intended to be made capable of exerting. In a bridge of 400 feet opening, between the points of suspension, and 25 feet wide in the clear, there would be needed 5 cables on each side, each of which would be composed of not less than 500 strands of wire. Or, there would be required for such a bridge, 10 cables, about 3 inches in diameter, each of which would resemble, when in place, a solid bar of iron, about 750 feet long; the whole number possessing an absolute force of 2500 tons.

A coat of varnish applied to every wire previously to the formation of the cable, offers an adequate protection against oxidation.

8. There are many reasons adduced for the preference given to wire cables, over the chains of bar iron, which they have nearly superseded. It is not possible to obtain iron free from flaws, though all reasonable precaution be observed in its manufacture; and it is not always practicable to detect the flaws by the test to which each bar is subjected prior to its employment in the structure. There is no practicable means, either, of preventing injury to the material, from the sudden and extreme variations of temperature incident to a high northern latitude.

These difficulties, though not sufficient to offer any very serious objection to the employment of the metal in this state, are, nevertheless, considerations of sufficient weight to be avoided when possible.

Wire cables are not liable to these objections.

9. But the great superiority of this material consists in the remrakable increase of tenacity which is imparted to iron by the process of wire drawing. The structure of iron, in bars, is somewhat chrystaline. By converting it into wire, the granular particles of which it is composed, are elongated, and the structure becomes fibrous. The consequence of this change appears to be an extraordinary increase of strength and toughness. The experiments of M. Seguin authorize us in valuing this increase, for the wire employed in the construction of bridges, at nearly 100 per cent.

OF THE APPLICATION OF THE SYSTEM.

10. It is far from the design of the writer, to recommend the exclusive use of this sort of bridges in place of any of those in common practice. The evidence of merit in bridge or civil architecture, is not to be found in a rigid adherence to any particular mode of construction. That plan is best which best subserves the intention of the builder; which best satisfies the essential conditions to be fulfilled.

If the object be to erect a bridge where a very extensive communication is likely to be maintained for all time, and great inconvenience would result from the interruption of the passage, even at the most remote periods; where the consideration of cost is secondary to that of perfect solidity, and the necessity of preserving the navigation is not an essential condition, the expense of constructing stone arches may, with propriety, be encountered.

Such a site corresponds with the position of the London and Waterloo bridges on the Thames; the Pont d'Neuilly on the Seine; the bridge of Bordeaux on the Garonne, and various other remarkable works in different parts of Europe.

If, on the contrary, the intercourse were inconsiderable, the price of timber low, and the expense of erecting piers not likely to be great—conditions which apply to many points on the Delaware, Schuylkill, Susquehanna, and other rivers of the United States, above their confluence with tide—any of the approved varieties of American wooden bridges, might be advantageously adopted.

But there are cases where neither stone arches nor wooden superstructures can be judiciously employed—and some method more permanent than the one, more durable than the other, and cheaper under the circumstances, than either, is indispensable to the accomplishment of the design.

11. The peculiar advantage of the suspension bridge, is due to the power which it furnishes of bridging rivers of great breadth, without the necessity of intermediate supports. *If the breadth of the stream be not over the third of a mile, and the object is sufficient to justify the cost, a bridge may be constructed without the need of a pier in the channel.* Where it is expedient, therefore to avoid obstructing the water-way, or impairing the navigation; where it is essential to elevate the flooring far above the surface of the river, or where the expense of permanent foundations for the piers will be great, this system will be found to present remarkable advantages.

12. To give some examples, in point, we will suppose that it were intended, as has sometimes been suggested, to construct a bridge across the Mississippi, somewhere near its confluence with the Missouri. In this situation a resort to the most approved kind of wooden bridge would be found to be both exceedingly expensive, and extremely hazardous. The breadth of the river being some 6000 feet, there would probably be needed about 35 piers for its support. The river being subject to frequent freshets of great height and power, and being navigated, at those times, by steamboats of the largest class, the level of the flooring should be elevated more than 100 feet above the surface of the river, in its ordinary state, to permit the passage of the boats beneath it.

Even at this elevation, the navigation of the river would be somewhat impaired by such a bridge; and the cost of raising so many piers to so great a height would not only be enormous, but the piers when built, would present an obstruction to the channel, which would endanger the foundations and jeopardise the adjacent shores. And still, after encountering these difficulties, and submitting to the inconveniences which would result

from the most successful consummation of the enterprise, the superstructure would at all times, be liable to be consumed by fire, readily communicated by a spark from a steamboat.

To erect a suspension bridge at the same point, would require but 5 or 6 piers. The bridge so constructed would offer no appreciable obstruction to the river, or impediment to the navigation. The danger arising from freshets would be entirely obviated, and the edifice being chiefly of stone and iron, would be perfectly secure against destruction from fire. The first cost of the bridge would be less than that of a wooden one; its durability—apart from the risk of accidents—would be immeasurably greater; and, as a beautiful and commanding ornament, its appearance would be unrivalled by any structure in the country, and, perhaps in the world

13. The same considerations obtain in discussing the project of a bridge over the Ohio, in any part of its course. The freshets in this stream, also, rise to such a height, that to admit the passage of steamboats beneath the structure, the flooring ought to be elevated nearly 100 feet above the level of the summer surface of the river. The construction of piers would consequently involve a heavy expense, would be equally exposed to the violence of the river, and offer the same impediments to the navigation, as would result from a similar work over the Mississippi. There are many parts of the Ohio. where a suspension bridge could be conveniently constructed without the aid of a single pier in the water, and but few places where more than one pier would be really advisable.

14. The same observations apply to the Niagara river, below the Falls, where the gorge could be readily spanned by a beautiful edifice, which would involve but an inconsiderable expense, and stand firm for ages.

15. It has frequently been proposed, of late years, to construct an additional bridge across the Schuylkill at Philadelphia. The citizens of Philadelphia have had some experience of wooden bridges, in the use of the three that have been erected, at different periods, across this stream.

The style of these bridges is different. That at Market Street, is supported on well executed and permanent piers of masonry. That at Fairmount, spanned the river at a single sweep; and that at Gray's Ferry is supported on piers, though with foundations less secure than those of the "permanent bridge." One has recently been destroyed by fire, and both the others are liable to the same accident.

The foundations of Market Street bridge, are too excellent to admit the suspicion that they will be endangered by any violence ever likely to be exerted by the floods of the river. Those of the bridge at Gray's Ferry were obtained by a less expensive process; but having resisted serious freshets since their erection, it is probable that they may not yield to those which will hereafter occur.

It is of much consequence in the establishment of a bridge across a river, which, like the Schuylkill, is subject to discharge great quantities of ice, when swollen by freshets, to leave the channel clear, and the course of the current unobstructed. The erections of piers is directly adverse to this condition. They interrupt the progress of the largest masses of ice; which form a barrier to the water, and by increasing the height of the freshets above the piers, and accellerating the current between them, endanger the safety of the edifice, and, at the same time, frequently submerge property of value along the shores.

16. A suspension bridge across the Schuylkill, would leave the channel unobstructed, as at present. It would be secure again destruction by fire, or by flood. It would be much less expensive than a wooden bridge, constructed on permanent piers, and not more expensive than the lowest class

these difficulties, and submitting to the inconveniences which would result

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of those bridges that could, with any show of propriety, be admitted. It would be not less firm than one of timber, and scarcely less durable than one of stone. As a contribution to the architecture of the city, and an ornament to the Schuylkill, it would be unsurpassed.

17. The lightness, grace and beauty of these structures, when tastefully designed and judiciously applied, can be only adequately appreciated when witnessed in place. No drawing or description can properly represent their appearance.

And the edifice never parts with its beauty. The form it assumes, when first thrown over the stream, is the result of natural laws, which are always in action, and will preserve its position and figure for ever. It may, at times, undergo a slight inflection—imperceptible to the eye—when heavily and unequally loaded, but immediately recovers its position on the removal of the charge.

18. There have been many bridges constructed in Europe on this principle, which are familiar to instructed engineers of all countries. Some of these, on the Rhone, are very beautiful, and some are regarded as among the most remarkable of the victories of modern art.

The bridge over Menai, is a grand and imposing edifice. That at Freiburg, in Switzerland, is a still more commanding structure, though much less generally known. The former, at the time of its completion, was one of the most elevated bridges in the world, and exceeded, by many feet, the span of the broadest arch that had ever before been thrown. The bridge at Freiburg, is hung still higher above the stream that flows under it, and exceeds, in the space between its abutments, by more than one hundred yards, the span of that of Menai.

The distance between the points of suspension of the Freiburg bridge is 880 feet, and the elevation of its flooring is 167 feet above the bed of the river.

RICHMOND, APRIL 15, 1839.

AMERICAN LOCOMOTIVES IN ENGLAND.—Notwithstanding the views of certain English Journals as to the folly of using American Locomotives we are pleased to find from the following, that they have performed the allotted task with the greatest ease.

AMERICAN LOCOMOTIVE ENGINES.—It will be recollected that a contract had been entered into between the Birmingham and Gloucester Railway Company, and Mr. Norris, of Philadelphia. U. S. for the supply of Locomotives for the Gloucester Railway. The contract was conditionally made on the first engine manufactured by Mr. Norris, performing certain work agreed upon. As much interest has been felt in this country with reference to the contract, and as some doubts were entertained as to the correctness of the representations made respecting these engines, we have pleasure in giving the following particulars as to the engine sent over to this country by Mr. Norris, and the work it has actually performed on the Grand Junction Railway, in conformity with the agreement to which we have alluded. "The England" weighs about eight tons, without water or fuel; she is built much lower and smaller than the engines commonly in use here, and has six wheels, the driving pair being four feet in diameter. The cylinders are ten and a half inches in diameter, and are enclosed in proper cases to prevent radiation—stroke eihteen inches. The machinery is of the simplest construction, and consists of a much smaller number of parts than we have been accustomed to see. The cylinders are placed on the outside of the framework, which allows the advantage of a straight

structed on permanent piers, and not more expensive than the lowest class

axle; and the general appearance of the engine more nearly resembles that of the old "Rocket" engine than any which we are acquainted with. The engine is got up in a most superior style, and is finished, even to the most minutest particular, in a very beautiful and workmanlike manner; every part having been executed with perfect accuracy, by means of self-acting machinery. As a proof, indeed, of the mathematical correctness of the work, we may mention that the steam-tight joints are formed simply by the bringing into contact of metallic surfaces; the workmanship of which is so true, as entirely to supersede the necessity of packing of any kind. The boiler is similar to those used in engines manufactured in this country, but it contains only seventy-eight tubes; instead of from 100 to 140, the number commonly used in those on our railways; and the consumption of fuel compared with the work performed, is we understand, very small. The task undertaken to be performed by "England" was to run from Birmingham and Warrington, fourteen journeys each way, carrying 100 tons in the gross, and performing the distance eighty miles, at the rate of twenty miles per hour, which the engine has accomplished considerably within the specified time of four hours; the average time having been 2 hours 50 minutes, or the actual running time, without stoppages, from 3 hours 9 minutes to 3 hours 19 minutes. On one occasion it is stated that the engine brought into Birmingham the enormous load of 126 tons, drawing it up the inclined planes without any assistance; and on no occasion has it failed to perform the required duty, nor has even the least derangement of any part of the machinery taken place. It should also be mentioned, that the various parts were never put together until its arrival in this country, when they were first fitted at Liverpool, the day previous to making a trip; nor has a tool been applied to the engine since they were first set up. We understand the conditional order to Mr. Norris for ten engines, of similar capability has been confirmed.---[London Morning Journal.]

CEROGRAPHY.---Under this name we notice a new mode of engraving, the invention of Sydney E. Morse Esq. Editor of the New York Observer.

The specimen which we have seen is a portion of a map of Connecticut which has the appearance of a well executed wood engraving but of a size much larger than is generally attainable in that art.

The following notice from the New York Observer gives a comparison with other methods. We cannot but remark that Cerography appears to promise the readiest and neatest execution for Tographical maps, of all the various methods in use.

CEROGRAPHY.---To enable our readers to understand the value of the new mode of engraving, which we call Cerography, we will first state briefly some of the prominent advantages and disadvantages of the three modes of engraving now in use, viz: *Lithography*, or *stone* engraving; *Copper-plate*, or *metal* engraving; and *Xylography*, or *wood* engraving.

The great advantage of *Lithography* is the ease with which the engraving is executed. With a pen or crayon, and an ink properly prepared, a drawing is made upon the stone almost as rapidly as it could be done with a pen and ink, or pencil, on paper, and when the drawing is finished, the plate is ready for the press.

The disadvantages of Lithography are, 1. Lines are not clear and dis-

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tinct. They have a muddy and ragged appearance, which is offensive, especially when the eye dwells upon the print. 2 The engraving is not durable under the press; it frequently requires renewal after only one or two thousand impressions have been taken. 3. The printing is expensive. From plates of the best dimensions, for printing a large amount of surface in a given time, (say, plates of two feet by 18 inches) it is not usual we understand, to print more than 1000 square feet of paper in a day of ten hours.

The great advantage of *Copper plate* or *metal* engraving, is, that lines can be made perfectly clear and distinct, and of the utmost fineness and delicacy.

The disadvantages of copper-plate engraving are, 1. The engraving, as compared with Lithography, is expensive. To engrave a map on copper will usually cost at least three or four times as much as to draw it upon stone; and to engrave it on steel, probably six or eight times as much. 2. Copperplate is not durable under the press. It will usually require to be retouched, at half the expense of the original engraving, after 10,000 copies have been taken; and although three or four times 10,000 may be struck on steel, the greater cost of the engraving on steel will still give Lithography the advantage of metal in cheapness. 3. The printing from copper plate is expensive. It is even more expensive than printing from stone. From plates of the best dimensions, [say, plates of one foot by 18 inches,] it is not usual to print more than 400 copies, [equal to 600 square feet] in a ten-hour day.

The great advantage of *Wood engraving* is the cheapness of the printing, and the convenience of using the blocks in the same form with type. If one side of this paper, [3 feet by 2, equal to 6 square feet,] they could be printed easily under a single Napier press, at the rate of 1000 an hour, making 10,000 copies, or 60,000 square feet, in a ten-hour day. This is sixty times as fast as lithographic printing, and a hundred times as fast as copper-plate printing! With a double Napier, these rates could be doubled. Such a rate of printing, of course, would never be attempted where beautiful work was the object; but even with a medium sheet, and under the hand press, 6000 square feet of very handsomely printed wood-cut prints may be obtained in ten hours. This is ten times as many as are usually got from copper, and six times as many as from stone.

The disadvantages of wood-cuts are, 1. The imperfection of the engraving. This is especially applicable where there is much lettering and cross lining in black, as in maps. The most accomplished wood-engraver in this country informs us that the map of Connecticut, which we published a few weeks since, cannot be equalled on wood, the difficulties of such work, from the very nature of wood-engraving, are so great. 2. The engraving on wood, except from a limited class of subjects, is very expensive. The map of Connecticut to which we have referred, could be beautifully engraved on copper for less than a fourth part of the expense which would be incurred in cutting it out in a rough way on wood.

The advantages of *Cerography* are, 1. The engraving of many subjects can be executed with a rapidity approaching very near to that of drawing upon stone; and the whole expense of a plate prepared for the press will ordinarily be less than that of a plate in copper or wood. 2. The plate is durable under the press. A million good copies may be struck from it; and as it can be stereotyped, the number of plates may be multiplied indefinitely at a trifling expense, and each plate will give a million copies. 3. Lines of all engravings, except, perhaps, the very finest class, can be made with nearly or quite the same perfection as in copper or steel, and with less

labor. 4. We know of no limit to the size of cerographic plates. We suppose they may be made as large as the largest bed of the Napier press. 5. The printing is executed with the common printing-press, and of course as rapidly as wood-cut, or letter-press printing; that is, at the rate of 6000 square feet in ten hours, for beautiful work under the hand-press, or 60,000 under the single Napier.

With this statement. our readers can judge, as well as ourselves, of the effects which Cerography, in the hands of accomplished artists, will probably produce on the other arts of engraving.

We suppose that, with an improvement of which it is evidently susceptible, it will also have an important effect on the art of printing, especially on printing in the characters of the Chinese, Hindoo, and other oriental languages. Even in its present state, it will no doubt be used as a substitute for type setting in some cases; but of this we will say more hereafter.

CEDAR QUARRIES.—On asking a friend from Oswego, the other day, who used this term, what it meant, he informed us that much of the cedar which comes from Lake Ontario is absolutely dug out of the soil. On some of the islands in that lake, which furnish great quantities of that valuable timber, there has not been growing a single tree for many years.—Generation has apparently succeeded generation of this timber, and fallen, and been successively covered with earth, and is now dug out for railroads, fence posts, etc. and in a perfectly sound state.

The above is from the Cultivator. Persons who have been on the island have stated to us similar facts. We believe, however, the quarries are getting exhausted of their most valuable mineral—the red cedar, or that it is so deeply imbedded, that the labor of excavation is not sufficiently rewarded. During this season nearly all the cedar importations have been of the white species. We have heard it stated that on some of the islands—the Ducks and Pidgeons for instance, at the northeastern termination of the lake—there are subterranean passages pervading their whole area. That the roof, or exterior surface, seems to be composed of agglomerated earth matted and held together by roots of trees which rest upon it and have covered it with a thick growth of timber. The vaulted passages or dens below are filled with cedar logs lying in every variety of position, and which were no doubt formerly, like the rafters of a house, gave support to the superincumbent mass. From the accounts we have had, there are more wonderful labyrinths constructed by nature on Lake Ontario, than that of old upon the banks of Lake Mœris.—[*Oswego Palladium.*]

☞ We have to make an apology for a succession of errors in these three numbers. They are all incorrectly *numbered* and *dated*, and the last one incorrectly folioed. There are *two* parts marked *No.* 9,—from which the subsequent numbers are all wrong. We were, at this period, about to change our printer, in order to have the work done as formerly, under our own roof—we do not, however, believe that the errors were intentional, but arose from *gross carelessness.* It will be perceived that there are *two parts* marked *number nine*, and the folios of the last number are a repetition of the folios of the *preceding number.* It is believed, however, that no *serious* accident will occur from these errors, unless they should perchance, throw the Locomotive off the track. Yet it is mortifying to

have them occur so frequently; we anticipate from our present arrangement, more punctuality, and errors less frequent.

☞ In consequence of my long absence during the past winter and spring, the publication of numbers *ten, eleven, and twelve*, of this volume, has been vexatiously delayed. These three numbers are now presented in *one cover*, and complete the volume. D. K. MINOR.

NEW ARRANGEMENT.—I have disposed of my interest in the Railroad Journal, to *Mr. Egbert Hedge*, who, being a practical printer, will attend personally to the mechanical department, and see that it is hereafter issued punctually at the proper time.

It is with great reluctance that, after having established, and continued it for more than seven years, I relinquish my interest in the Journal. It was projected and commenced more with a hope of promoting the cause of Internal Improvement in this country, than with the anticipation of much profit from its publication; I shall not therefore express an opinion as to its influences, whether for good or for evil upon the great cause to which it has been mainly devoted---yet I may without hesitation say that the anticipation of *not much profit* has been, to the *fullest extent* realized. I do not, however, regret having devoted so much time to it; nor shall I, even when my *pecuniary* interest in it has ceased, forget it entirely; but shall hereafter devote as much time to its concerns as other avocations necessary for the support of my family, will permit; and I do not give up the hope, that I may, with returning prosperity, yet acquire an interest in it again; that will however, depend much upon the success which shall attend the collection of accounts, now due.

To the real patrons and friends of the Journal, who have contributed to its continuance for so long a period, by *punctual payment*, as well as by valuable contributions to its columns---and also to the Corps Editorial, from whom it has received so much kindness, I desire to express my grateful acknowledgements, and I will avail myself of this opportunity to solicit for my late associate, Mr. Schaeffer, and my successor Mr. Hedge, a continuance of their patronage and kind offices, as they will, I am sure, richly merit them. D. K. MINOR.

It will be seen by the above notice that I have purchased of D. K. Minor his interest in this periodical---the RAILROAD JOURNAL, and MECHANICS' MAGAZINE. I shall devote my personal attention to the mechanical department, and shall endeavor to have the numbers hereafter issued punctually at the proper period, in a manner satisfactory to its readers.

I am prepared to do with promptness, Job Printing of all kinds, especially Railroad Reports, Circulars, and all matters pertaining to Internal Improvement. EGBERT HEDGE.